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Measurement of Sales of Apples in Retail Stores

By Earl E. Houseman

The relative merits of different methods of measuring volume of retail sales of particular commodities has been a debated subject in recent years. As a byproduct of an experiment in retail store merchandising, a direct comparison of some alternative methods is made in this paper, a matter of importance, we believe, to persons interested in the measurement of retail sales.

IN OCTOBER and November 1953, an experiment was conducted in 12 retail stores in Pittsburgh to ascertain the effects of four methods of merchandising on the sale of apples.[1] A report of information obtained in the study of merchandising methods will become available. In this article we are concerned with alternative statistical techniques, therefore we shall discuss the experiment only to the extent necessary to provide a description of the data upon which results here reported are based.

Plans for the experiment included provision for obtaining information weekly, for an 8-week period, on total sales of apples by adjusting each store's purchases for inventory changes and losses. Total sales were the variable to be used in evaluating the effects of treatment. But, in addition, a count of customer units and the pounds of apples bought by each were recorded every day in each store for two 45-minute periods. A customer unit was defined as one or more persons shopping together, irrespective of whether apples were bought.

From this experiment it was possible to compare (1) lbs/45m (pounds sold per 45-minute period) and lbs/100c (pounds sold per 100 customer units) as derived from the observation of customer purchases, with (2) total quantities of apples sold by the 12 stores during each week. The method of estimating retail sales from a sample of stores wherein total sales are obtained by adjusting each store's purchases for inventory changes and losses will be referred to as the "audit method."

The method of observing customer purchases during specified hours will be referred to as the "observation method." The observation method involves the sampling of stores *and* time (sample of hours), in contrast to the audit method, which requires only the sampling of stores.

With the exception of a relatively few observation periods with missing data, as just indicated, data were available for 12 observation periods (two each day for 6 days) for each week and for each store over an 8-week period. For convenience in the analysis, substitutions were made for the periods with missing observation by visually inspecting the data, deciding upon a range of values within which the actual value for the missing period probably would have been, and substituting a number selected at random within that range. For various reasons, approximately 2 per-

[1] This study was conducted by the former Production and Marketing Administration of the United States Department of Agriculture in cooperation with Pennsylvania State University and Cornell University.

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cent of the observations were missing, but in many of these cases notes made by the field staff were available. These were helpful for assigning substitute values for missing observations. It seemed clear that the assignment of values for missing data could have only a negligible effect on the results to be presented.

The 12 Pittsburgh stores in the experiment, members of the same chain, were distributed over the city. They encompassed a variety of conditions. None had a gross business of less than roughly $20,000 a week.

Responsibility for maintaining the experiment was assigned to six men, with two stores to each man. They helped to prepare displays, kept an appropriate supply of apples on hand, and collected necessary information. Working arrangements between field staff and test stores were such that data on total weekly sales are believed to be virtually without any measurement error. It was not possible for the field supervisor to check the extent to which customers who did not buy apples may have been missed in the count of customers, either because of crowded conditions during rush periods or through observers' inattention at other times. But the data provide a useful source of information for comparing alternative methods of measuring retail sales.

As the measurement of sales or changes in sales through time and the measurement of effects of merchandising practices are different problems in terms of study design, they are discussed separately.

Measurement of Changes in Volume of Retail Sales

To evaluate alternatives, it is necessary to specify a true value for the population sampled and to consider the departures from the true value of estimates based upon the alternative methods. It is assumed that we are trying to estimate

$$R_i = \frac{T_i}{T_b}$$

where R_i is the ratio, for all stores in the defined universe, of the true total sales, T_i, for the ith week to the true total sales, T_b, during some base week. It is possible to design samples for estimating T_i but for this study the ratio R_i is considered as the true value to be estimated instead of the universe total, T_i, because of the problems involved in any attempt to expand either pounds per hour or per 100 customers to a total, particularly in the practical setting under which observations during specified hours have been made in past surveys or experiments. Let us consider lbs/45m versus lbs/100c as estimates of R_i before contrasting the audit method with the observation method.

Pounds per 45-minute period vs. pounds per 100 customers.—To compare these two measures of rate of sales, the data from the Pittsburgh apple experiment were divided into 12 subsamples. One observation period a week for each store was used in each subsample. With the aid of Latin-square arrangements it was possible to have each subsample consist of an equal number of large and small stores by 2-day time-periods within a week. *The underlying idea in the subsampling was to obtain 12 subsamples such that any one of the 12 might have been the sample of hours chosen if the project had been planned originally so that only one observation per week was taken in each store.*

The schedule of hours for observation in each store changed from one week to the next but the same schedule was used for weeks 1, 3, 5 and 7, and another for weeks 2, 4, 6 and 8. Treatments (merchandising practices) were changed every 2 weeks. Hence, between weeks 3 and 4, there was no change of treatments but the schedule of observation hours for a given store was different for each of the two weeks. From week 4 to week 5, both the treatments and schedule of observation hours changed.

The field staff adhered closely to the schedule of hours for observing customer purchases. Observations for any given store and day were identified as first and second observations. As the set of 12 subsamples was held constant from week to week, the store-hours in any given subsample are matched between odd numbered weeks and between even numbered weeks. This also means, for example, that the first observation in store A on Tuesday in an odd numbered week must be in the same subsample as the first observation in store A on Tuesday in an even numbered week.

For each subsample, pounds of apples bought per 100 customers and pounds bought per 45-minute period were computed for each week. As a means of getting the two measures on a common basis for comparison, ratios were then computed for each subsample for each week to the preceding week, for each even numbered week to the preceding even numbered week, and for each odd numbered week to the preceding odd numbered week.

TABLE 1.—*Summary of comparisons of 12 subsamples*

Line	Item	Weeks compared [1]							
		4/3	5/3	5/4	6/4	6/5	7/5	7/6	8/6	8/7
1	Ratios of total sales	0. 42	0. 44	1. 05	1. 04	1. 00	0. 98	0. 99	1. 66	1. 68
	Pounds per 100 customers									
2	Ratios for the combined subsamples [2]	. 59	. 52	. 89	. 85	. 96	1. 02	1. 06	1. 46	1. 38
3	Averages of the subsample ratios	. 60	. 53	. 91	. 88	. 98	1. 06	1. 10	1. 54	1. 43
4	Root mean square errors [3]	. 20	. 16	. 28	. 31	. 19	. 29	. 27	. 47	. 43
	Range of values of subsample ratios									
5	Lowest	. 50	. 37	. 61	. 57	. 80	. 57	. 66	1. 06	. 99
6	Highest	. 79	. 75	1. 48	1. 48	1. 41	1. 58	1. 43	2. 56	2. 04
	Pounds per 45 minute period									
7	Ratios for the combined subsamples [4]	. 53	. 49	. 92	. 82	. 89	. 93	1. 04	1. 64	1. 57
8	Averages of the subsample ratios	. 54	. 51	. 93	. 85	. 89	. 96	1. 12	1. 74	1. 60
9	Root mean square errors [3]	. 15	. 16	. 29	. 35	. 24	. 26	. 36	. 61	. 38
	Range of values of subsample ratios									
10	Lowest	. 41	. 31	. 58	. 53	. 64	. 52	. 71	1. 06	1. 02
11	Highest	. 68	. 69	1. 36	1. 65	1. 41	1. 40	1. 78	3. 19	2. 25

[1] For example 4/3 refers to ratios of week 4 to week 3.

[2] The values recorded in this line are $\left(\frac{t_i}{c_i}\right)\left(\frac{c_j}{t_j}\right)$ where t and c are total pounds sold and total customers counted for all 12 subsamples and the subscripts refer to weeks.

[3] For any column (pair of weeks) the root mean square error is $\sqrt{\frac{\Sigma(r_i - R)^2}{12}}$ where r_i is the ratio for the ith subsample and R is the true ratio (line 1 of this table).

[4] The values recorded in this line are $\frac{t_i}{t_j}$ where t is total pounds sold for all 12 subsamples and the subscripts refer to weeks.

The data for each subsample were also converted to an index using the eighth week as a base, but that analysis is not presented here as the results were essentially the same.

The "true" ratios, of which the subsample ratios should be estimates, are given in the first line of table 1. These ratios are based upon the total sales of apples by the 12 stores as derived from the audit method. It is clear from the table that neither lbs/100c nor lbs/45m, for the size of sample involved, reflected change with a satisfactory degree of accuracy. From a comparison of lines 2 and 7 with line 1, it is clear that subsampling time even to the extent of taking two observations each day did not provide good estimates of the ratios for all pairs of weeks. Part of the data underlying table 1 are presented graphically in figure 1.

Because of a sharp increase in price at the end of the third week, the quantity of apples sold during weeks 4, 5, 6 and 7 was comparatively low until week 8, when the price dropped. It is interesting that on the two occasions (weeks 3 to 4 and 7 to 8) when the greatest change occurred, as shown by the "true" ratios, neither lbs/100c nor lbs/45m came close to reflecting the full extent of the true change but lbs/45m was appreciably closer in both cases. Incidentally, week 7 included Thanksgiving Day. Under the concept of pounds per hour that was used for this analysis, a regularly scheduled observation period that falls on a holiday is counted as an observation period with zero sales.

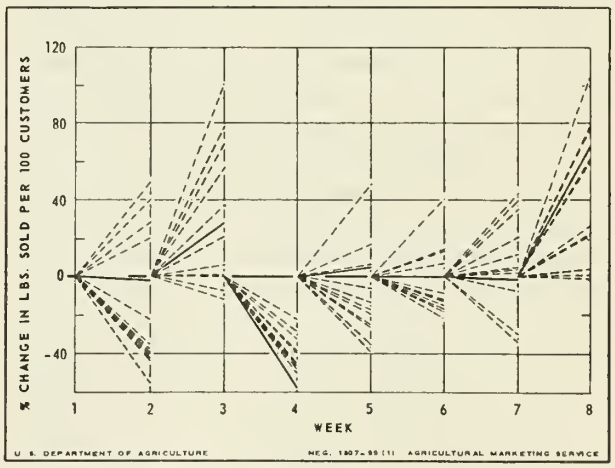

FIGURE 1.—Week to week changes in pounds of apples sold per 100 customers for each of 12 subsamples (dotted lines) compared with changes in actual sales by same stores (solid lines).

Note that the ordinary standard deviation, which would be a measure of the variation among the 12 subsamples, was not used in table 1 as a measure of precision. Instead, the root mean square error was used, which is the square root of the average of the squares of the deviations of the 12 subsample ratios from the "true" ratio. The two principal reasons for using the root mean square error instead of the standard error were: (1) There might be some biases in the time subsamples, and (2) even if the subsamples were unbiased (or random) samples of time, lbs/100c, technically speaking, gives estimates having bias (although the bias might be small) in addition to the usually negligible bias that exists in ordinary ratio estimates.

Because of the possibility of a bias, as just indicated, and because holidays, weather, and other factors influence the number of customers during a specified hour of the week, it was anticipated that the standard deviation for lbs/100c might be considerably less than the standard deviation for lbs/45m. For lbs/100c and lbs/45m the simple average of the 9 root mean square errors in lines 4 and 9 of table 1 and the simple average of the corresponding standard deviations are as follows:

	lbs/100c	*lbs/45m*
Root mean square error	.29	.31
Standard deviation	.25	.29

This shows that the standard deviations were not much less than the root mean square errors and that on the average lbs/100c and lbs/45m were about equally accurate. However, the relative differences are not entirely independent of the rate that time is sampled. As the rate (number of periods of observation) for sampling time is increased one would expect that the root mean square errors would decrease somewhat less rapidly than the standard deviations, and that the root mean square error for lbs/100c would decrease less rapidly than the root mean square error for lbs/45m.

Errors displayed in table 1 are a result of subsampling time, and do not reflect variability between stores. The errors are attributable only to the fact that observations on customer sales were limited to selected hours rather than covering the entire time that the stores were open—assuming no measurement errors in the total sales based on the audit method. It is not clear, *a priori*, that the comparative precision of lbs/45m and lbs/100c must be about the same when the between-store component of error is brought into consideration. But as we are concerned with estimating "change" rather than "level" from the same sample of stores through time, one might expect, intuitively, that the accuracy of the two estimators would remain about the same when between-store variation is added.

To make a comparison, taking store differences into account, it was necessary to decide whether to do this by use of variance formulas or by drawing a number of subsamples of stores and examining the differences between the subsamples. The latter method was chosen primarily because of the small number of stores involved and because the appropriate variance formulas, which are approximations, are of doubtful validity under the present circumstances. Note, when lbs/100c for one week is divided by lbs/100c for another, that the variance of a quantity like $\frac{X_1}{X_2} \cdot \frac{X_3}{X_4}$ is involved, where X_1, X_2, X_3, and X_4 are all variables.

Thirty subsamples of 4 stores were selected from the 12 stores by use of a table of random numbers. Totals of the 12 observation periods for each store-week were used in the computation of ratios for each subsample of stores to be compared with the true ratios. Thus, the analysis followed the same pattern as that for results given in table 1. In this case we are dealing with subsamples of stores whereas in the previous case we were dealing with subsamples of time. Results from subsampling of stores are shown in table 2. The section of the table headed "total sales" does not involve sampling of time, whereas the sections on lbs/100c and lbs/45m involve sampling time to the extent of 12 45-minute observation periods per week in each store.

Again, the two measures, lbs/100c and lbs/45m, appear to be about equally accurate.

Audit method vs. observation method.—It is clear from theoretical considerations that, given a probability sample of n stores, the standard error of $r_i = \frac{t_i}{t_b}$ is less than the standard error of $r'_i = \frac{t'_i}{t'_b}$ where t_i and t_b are sample totals from the audit method for the ith week and a base week, respectively, and t'_i and t'_b are sample totals of pounds sold during specified hours from the observation method. In fact, if only one hour is observed each week in each of the n stores, the sample on which r'_i is based is in a sense only roughly 2 to 3 percent as large as the sample on which r_i is based. If any

TABLE 2.—*Summary of differences among 30 subsamples of 4 stores each*

Line	Item	Weeks compared			
		5/3	7/5	6/4	8/6
1	Ratio of total sales ("true" ratios)	0. 44	0. 98	1. 04	1. 66
	Total sales (audit method):				
2	Average of subsample ratios	. 44	. 98	1. 06	1. 67
3	Standard error	. 08	. 17	. 11	. 31
	Range of values of subsample ratios:				
4	Lowest	. 32	. 71	. 85	1. 06
5	Highest	. 60	1. 25	1. 25	2. 26
	Pounds per 100 customers:				
6	Average of subsample ratios	. 52	1. 06	. 85	1. 56
7	Standard error	. 14	. 32	. 11	. 41
8	Root mean square error	. 17	. 33	. 22	. 42
	Range of values of subsample ratios:				
9	Lowest	. 27	. 69	. 64	1. 13
10	Highest	. 79	1. 74	1. 12	2. 21
	Pounds per 45 minute period:				
11	Average of subsample ratios	. 50	. 96	. 83	1. 75
12	Standard error	. 12	. 26	. 14	. 43
13	Root mean square error	. 13	. 26	. 26	. 44
	Range of values of subsample ratios:				
14	Lowest	. 30	. 68	. 61	1. 07
15	Highest	. 73	1. 49	1. 19	2. 45

measurement errors for the audit method are under control, it is clear from theory and experience that the error in r_i as an estimator of R_i must, on the average, be much smaller than the error in r'_i. Even with 12 different 45 minute periods stratified by time, the difference as indicated in table 2 (line 3 compared with line 13) is substantial. This is nothing more than a reflection of the fact that if one has a sample of n sampling units (stores) the error will be greater when the n sampling units are subsampled than when they are enumerated completely.

Next, let us consider $r''_i = \frac{t'_i}{t'_b}\frac{c_b}{c_i}$

where c_i and c_b are the sample total numbers of customers counted during the observation periods for the ith week and base week, respectively. In other words, r''_i is the rate one would compute when using lbs/100c. It is not axiomatic, as was the case with r'_i, that the sampling error of r''_i as an estimator of R_i must be less than the sampling error of r_i. This partially explains the interest manifest in this article in comparing lbs/45m with lbs/100c. If the sampling error for r''_i is not appreciably less than the sampling error for r'_i, there is no hope for r''_i being better than r_i as an estimator of R_i. The results in tables 1 and 2 and the results of at least one other experience not reported here do not indicate any appreciable superiority of r''_i over r'_i.

We have been considering r_i, r'_i and r''_i as estimators of the parameter R_i; but if $R'_i = \frac{T_i}{T_b}\frac{C_b}{C_i}$, where C_i and C_b are total customer counts in all N stores in the population, is a satisfactory parameter to be estimating, then r''_i probably should be evaluated as an estimator of R'_i instead of R_i. The precision of r''_i as an estimator of R'_i does not, however, appear to be much different from the precision of r'_i as an estimator of R_i.

As estimators of R_i it is clear that r_i must be much better than r'_i. Therefore, if r'_i and r''_i are about equally good, the conclusion to be drawn is that estimates provided by the audit method must be more precise than estimates based upon lbs/100c from the observation method.

Two assumptions underlying the preceding statement are: (1) That the same number of stores would be used in the audit and observation samples and (2) that the sample does not change from week to week. The statement also overlooks the question of certain biases that might be associated with each method.

Measurement of Effects of Merchandising Practices

Pounds sold per 100 customers could also be used for measuring differences in merchandising practices under either the survey or the experi-

TABLE 3.—*Analysis of variance of data on apple sales*

Source of variation	Degrees of freedom	Mean squares		
		Pounds per 45 minute period [1]	Pounds per 100 customers [1]	Total sales
Replications	2	16. 5	178	1, 861, 000
Periods	3	68. 8	840	2, 594, 000
Replications × periods	6	9. 0	76	30, 000
Stores within replications	9	54. 5	962	680, 000
Treatments	3	66. 9	1, 022	1, 997, 000
Error	24	5. 8	89	134, 000

[1] Combined data from all observation periods.

mental type of study design. For the Pittsburgh experiment, a 4 x 4 Latin-square design replicated three times over stores was used—each treatment remaining in each store for a 2-week period. Using the Pittsburgh data, let us examine the comparative "power" of lbs/45m and lbs/100c from the observation method with total sales from the audit method for measuring differences between treatments (merchandising practices). This will be done without reference to the question of which measure is conceptually the more useful.

From a standard analysis of variance procedure, the results presented in table 3 were obtained for each of the three ways of measuring sales. As indicators of the power for discriminating between treatments, two criteria are appropriate, the "F" ratios for the treatment mean squares, and the coefficients of variation (square roots of the error mean squares divided by the general means):

	"F" ratios	*Coefficients of variation*
Total sales (audit method)	14. 8	0. 19
Full time sample (observation method):		
lbs/45m	11. 6	. 24
lbs/100c	11. 5	. 23
Average over the 12 subsamples:		
lbs/45m	[1] 3. 1	[2] . 57

[1] Average of the 12 treatment mean squares, from separate analysis of variance for each subsample, divided by the average error mean square.

[2] Square root of the average error mean square divided by the mean.

The full sample of time refers to aggregates of the 24 observations on a treatment in a store during a 2-week period. For this rate of sampling time, there is some loss in precision as compared with use of total sales, but a large loss in precision occurs when time is sampled only to the extent of one observation period per week.

Table 4 shows sales for each treatment as a percent of the total for all four treatments for each method of measuring sales. The three measures give about the same results when the full sample of time is used, namely, 12 45-minute periods of observation in each store each week. Percentages corresponding to those in line 2 of table 4 were computed for each of the 12 subsamples of time. There were large differences between the subsamples; for example, three of the 12 subsamples showed slightly greater sales for treatment A than for treatment B, and two out of the 12 showed sales for B at slightly more than twice the sales for A.

Discussion

The large variation among stores because of the range in size of stores and other factors is apparent. Likewise, for any given store, amount sold during an hour varies widely with a number of factors, including time of day, day of the week, and weather. Therefore, intuitively, one might regard lbs/100c as a good basis for measuring sales because of an expectation that such variations would not influence it as much as pounds per hour, or, for example, pounds per store in the case of the audit method. Incidentally, with the audit method lbs/100c can also be used if arrangements are made with the stores for getting the total number of cash-register "ring-ups."

A point that is sometimes overlooked is that different measures of rate of sales, such as pounds per 100 customers, pounds per store, and dollars worth of apples sold per $100 of sales of all com-

TABLE 4.—*Percentage distribution of sales of apples, by merchandising practices*

Item	Percentage of total sales by practice				
	A	B	C	D	Total
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
Total sales	17. 7	24. 5	29. 6	28. 2	100
Pounds per 45 minute period [1]	17. 5	23. 3	30. 3	28. 9	100
Pounds per 100 customers [1]	16. 9	22. 8	31. 8	28. 5	100

[1] Based upon the full sample of time.

modities or of produce, involve different concepts. These are conceptual differences that are more than just a question of whether distance, for example, should be measured in terms of inches or centimeters. Thus, the criteria for choosing a measure of rate of sales should include the utility of the different measures assuming no sampling error as well as sampling variability and biases.

Let us examine the coefficients of variation among the 12 stores in the Pittsburgh experiment, comparing lbs/45m and lbs/100c from the observation method and pounds per store from the audit method, by using aggregates for the eight weeks. For the observation method two levels of sampling time will be considered: (1) All 96 observation periods in each store over the 8 week period, and (2) 8 observation periods, one each week in each store.

Method	*Coefficient of variation among stores*
Audit, lbs/store	0.25
Customer, lbs/45m:	
96 observation periods	.34
8 observation periods	[1] .63
Customer, lbs/100c:	
96 observation periods	.38
8 observation periods	[1] .57

[1] Mean squares between stores were computed for each of the 12 subsamples. The square root of the average mean square for lbs/45m and for lbs/100c was divided by lbs/45m and by lbs/100c, respectively.

Remember, the present setting differs from that represented in table 2. We are now considering relative variation in estimates for a given time period, not relative variation in ratios of one time period to another. Under the present setting, presumably, a customer count has a greater potential for reducing variability because estimates of "level" are involved rather than "change" from a matched sample.

The coefficients of variation are estimates and, in this case, subject to rather large sampling errors. But a translation of these coefficients of variation into requirements for equal precision indicates for the observation method that roughly twice as many stores sampled at the rate of 12 observation periods (one each half day) per week would be required to provide the same precision as that provided by the audit method. If one observation instead of 12 is taken each week in each store, about 5 or 6 times as many stores would be required to obtain the same precision as that provided by the audit method. These statements about sample size should not be interpreted as applying generally.

It was clear, before making the above computations, that the coefficient of variation for lbs/45m must be larger than the coefficient of variation for the audit method. One might have expected the coefficient of variation for lbs/100c to be less than the coefficient of variation for lbs/45m. The failure of this to happen is evidently attributable, to a considerable degree, to one or more of three factors:

(1) The range of variation from store to store in total quantities of apples sold was rather limited because of the choice of stores for the experiment; hence the potentiality for a customer count being effective in reducing variation was rather limited.

(2) Customer buying patterns or habits differed considerably among some of the stores. This is believed to be the principal reason why, for example, customer counts for the two stores that sold the most apples were in the proportions of 2 to 1, whereas the difference in total quantities sold was only 10 percent. One of these two stores was in an outlying area. Most of its trade was of the "drive-in" type. The other store was in an

area in which population density was much higher. Most of its trade was of the "walk-in" type.

(3) Some differences exist from store to store in a "customer unit" because of differences in the physical arrangements within stores, differences between enumerators, difficulties of counting all non-apple-buying customers under crowded conditions. Possibly there are other sources of differences. In fact, one might think in terms of a different definition being associated with each store. For example, if a customer count involves counting customer units passing through the produce department, would one say that the definition of a customer unit is the same for two stores if the floor plan of one of the stores is such that 90 percent of the persons entering the store go through the produce department, whereas in the other only 70 percent pass through the produce department?

It is important to keep these three factors in mind when attempting to judge whether a customer count will be helpful for purposes of reducing sampling variation as compared to the lbs/45m estimator. They are the most likely reasons why the customer counts and pounds sold, during the observation hours, were not sufficiently correlated to more than offset the added variability through the introduction of customer counts. That is, since customer counts are subject to sampling error, when total pounds sold during the observation periods is reduced to lbs/100c, a component of variation is added. If the correlation between customer counts and pounds sold is not great enough to more than offset this added component of variation, lbs/100c must have a greater coefficient of variation than lbs/45m.

There is one additional point on which some comment seems warranted. Variations due to differences in size of store, for example, can be "controlled" in various ways. After variation attributable to one source has been effectively controlled by one means, little if anything is gained—in fact a loss might occur—by superimposing another control on the same type of variation. To be more specific, suppose, for example, that the observation method and the same sample of stores and observation hours through time are used to estimate changes in sales. Variation due to size of store and time of day or week is fairly well taken care of by the design. Hence, it is reasonable that lbs/45m and lbs/100c appeared about equally accurate in tables 1 and 2 and in the measurement of differences between merchandising practices. Other examples could be cited in both experimental and survey types of studies.

There are many practical aspects of the problem of choosing a method for measuring retail sales, a discussion of which is beyond the scope of this article.[2]

Summary

Sampling Error or Efficiency.—Regardless of whether a survey or a controlled experiment is involved, for a given sample of stores, the relative sampling error for either lbs/hour or lbs/100c from the observation method must be appreciably greater than the relative sampling error for either lbs/store or lbs/100c from the audit method, respectively. It is theoretically possible for lbs/100c from the observation method to have a smaller relative sampling error than lbs/store from the audit method. But this did not happen in the Pittsburgh study, and is almost certain not to occur when variation associated with size of store is "controlled" in the survey or experimental design. The results presented in this report indicate that a large loss in statistical efficiency occurs when, instead of total sales, the purchases of apples during a 45-minute period once a week in each store are used to measure rate of sales.

When the observation method has been applied, the statistical population has usually been restricted to the larger stores, at least partly, to avoid sending an enumerator to a store in which he

[2] In reviewing the preliminary draft of this article, M. E. Brunk of Cornell University made the following observation: "Your analysis clearly indicates the relative advantage of measuring movement rate by use of the audit method. But the movement rate alone does not provide the trade with the essential information needed. The trade needs to know *why* movement rates change, and this can be accomplished only by including data on retail prices and practices which affect such movement. Adding this information complicates the problem. It suggests the possibility of combining the audit method of determining movement rate with a probability sample of stores for the purposes of determining associated trade practices. From customer observations both types of information are obtained, but your analysis suggests that this may possibly be an inefficient approach to the problem. Certainly additional research is needed in order to determine the most practical method of such market reporting."

would frequently have no sales, or very few, to observe during an hour. For a survey type of operation, and with the audit method, one could use a probability sample of stores with allocation of the sample by size groups in a statistically optimum manner. A cut-off point might be used to eliminate stores below a certain size. But the statistical population would be less restricted, so the results, as estimates of rate of sales or change in rate of sales for a city, would be less subject to the potential biases attributable to any limitations placed on the kind of stores that are permitted in the sample. We should not overlook the fact that differences in sampling variation resulting from changes in specifications of the population are not of the same nature as differences in sampling error associated with alternative methods of sampling and estimation for a given population.

Because it is more precise, the writer believes the audit method should be generally used unless it fails because appropriate records are not available, because of noncooperation, or for similar reasons.

Differences in Concepts.—It has been pointed out that lbs/100c and pounds per store (or simply total sales of a particular commodity) involve a difference in concepts. We need to recognize that reduction of data to lbs/100c gives results with a particular meaning depending upon the meaning of the customer count. A difference of 10 percent in lbs/100c does not necessarily mean a difference of 10 percent in per capita purchases or a difference of 10 percent in retail sales. To illustrate, suppose the actual per capita purchases of a commodity were the same in January and April and that the family buyers went to the store 10 percent more frequently in April than in January. Pounds bought per 100 customers would be less for April than for January even though the rate of purchases per capita remained unchanged.

If a "treatment" is tried in a sample of stores and evaluated by comparison of data for the test period with data from the same stores for a base period—should the comparison be in terms of the relative change in actual sales, the relative change in lbs/100c, the relative change in the proportion of sales of the particular commodity to the sales of a group of commodities, or on some other basis? This question of concepts should not be confused with questions of experimental or sampling technique. The merits of each concept should be considered, assuming no errors of any kind, and then a choice should be made on the basis of joint consideration of the utility of the concepts and the experimental or survey problems associated with each.

Labor in the Marketing of Farm Food Products

By Kenneth E. Ogren and Kathryn Parr

Farm-retail price spreads and the farmer's share of the consumer's dollar have long been the concern of both producers and consumers, as well as legislative bodies and other public policy groups. The farm-retail price spread for many farm products is a large part of the retail price—about 85 percent of the costs of tobacco products, household textiles, and clothing at retail, and more than half of the retail-store cost of food. To develop an understanding of the size of these spreads and the variations between products and time periods, it is necessary to consider the services performed in getting the products from the farmers to the consumers and the costs of performing these services. This article describes the statistics compiled in the Agricultural Marketing Service for measuring labor costs as a component of the farm-retail spread and the uses of these statistics.

THE services of many workers are required to get products from farmers to consumers in the form, time, and place desired. More workers are now engaged in marketing [1] farm products than are employed in the production process on the farm. In 1954, about 5 million workers on a full-time basis were employed in the assembly, transportation, processing, wholesaling, and retailing of food products (table 1). Although no official series are available, an equal number of workers probably were performing similar functions for nonfood farm products—cotton and wool products, tobacco products, alcoholic beverages, leather products, and many others. This means that about 10 million workers on a full-time basis are engaged in marketing agricultural products. What we might call the "direct labor costs" of these 10 million workers amounts to about half of the total spread between what the farmer receives for his products and what the consumer pays. Numbers, wage rates, and productivity of labor are therefore major factors affecting trends in farm-retail price spreads.

What the Labor Series Measure

Agricultural Marketing Service prepares annual estimates of the total number of workers in the local assembly, transportation, processing, wholesaling, and retailing of farm food products (table 1). Workers in restaurants and other places that sell food for on-premise consumption are included in retailing. This series measures the full-time equivalent employment [2] of all wage earners and salaried employees, active proprietors of unincorporated businesses, and unpaid family labor.

The series on labor cost includes wages and salaries plus estimates for proprietors and family workers. Also included are estimates of supplements to wages and salaries. Among these supplements are employer contributions to social insurance, private pensions, welfare funds, compensation for injuries, and pay of military reservists. These payments are small compared with wages; they totaled about 0.5 billion dollars in 1953.

Estimates for proprietors and family labor are based on less reliable data than those for paid employees. Because many small retail stores are operated mainly by owners and members of their families, the number of persons engaged in re-

[1] "Agricultural economists have rather generally followed a broad definition of marketing, covering not only buying and selling but also such subjects as transportation, processing, and storage."—Waugh, Frederick V., Ed. READINGS ON AGRICULTURAL MARKETING. Iowa State College Press. Ames, Iowa. 1954. Page 2. As Agricultural Marketing Service measures it, the marketing margin refers to the total price spread between the producer and consumer. In this context, marketing includes all operations involved in moving agricultural products from farms on which they are produced to consumers at the time and in the form they are desired. It should be recognized that this broad definition of marketing differs from the concept of marketing accepted in some industries.

[2] "Full-time equivalent employment" measures man-years of full-time workers and the estimated equivalent in work performed by part-time workers. All statistics on numbers of workers in this article are computed in this way.

TABLE 1.—*Estimated number of persons and labor costs in marketing all farm food products, 1929–54* [1]

Year	Number of persons		Labor cost	
	Total	1947–49=100	Total	1947–49=100
	Millions	*Percent*	*Billion dollars*	*Percent*
1929	3. 42	73	4. 56	39
1930	3. 40	72	4. 48	38
1931	3. 25	69	4. 11	35
1932	3. 12	66	3. 50	30
1933	3. 16	67	3. 24	28
1934	3. 44	73	3. 65	31
1935	3. 46	74	3. 79	32
1936	3. 55	76	3. 98	34
1937	3. 74	80	4. 46	38
1938	3. 71	79	4. 47	38
1939	3. 83	81	4. 66	40
1935–39 average	3. 66	78	4. 27	37
1940	3. 95	84	4. 86	42
1941	4. 08	87	5. 35	46
1942	4. 16	89	5. 89	50
1943	4. 02	86	6. 26	54
1944	4. 11	87	6. 91	59
1945	4. 22	90	7. 61	65
1946	4. 46	95	9. 14	78
1947	4. 64	99	10. 75	92
1948	4. 71	100	11. 82	101
1949	4. 74	101	12. 44	107
1947–49 average	4. 70	100	11. 67	100
1950	4. 72	100	12. 96	111
1951	4. 85	103	14. 20	122
1952	4. 95	105	15. 13	130
1953	5. 02	107	15. 98	137
1954 [2]	5. 0	107	16. 5	141

[1] Includes number (on a full-time equivalent basis) and compensation of all persons engaged in assembling, processing, wholesaling, retailing, and transporting farm food products. Data for later years and revised data will be published annually in *The Marketing and Transportation Situation.*

[2] Preliminary estimate.

Compiled from statistics published by Departments of Commerce and Labor and Interstate Commerce Commission.

tailing food would be considerably understated if they were not included. Around a third or more of the workers in retailing are estimated to be proprietors or unpaid family labor. Family workers and proprietors are relatively unimportant in processing, wholesaling, and transportation.

As all the farm food marketed does not move into domestic civilian consumption, numbers and labor costs in table 1 include also the part of labor that is engaged in marketing farm food products that are sold to military services and those moved into export channels. Adjustments in overall estimates which are sometimes necessary for special analysis are described in the section on applications and limitations of these series.

How the Series Are Compiled

The series on labor numbers and costs are compiled from separate estimates made for processing, wholesaling (including local assembly), retailing, and transportation. These estimates are based upon data published by the Departments of Commerce and Labor and the Interstate Commerce Commission. As many adjustments of the original data are necessary in the derivation of these labor series, a somewhat detailed account of the assumptions and procedures are presented here. This will give potential users of the series an insight into the reliability of the series and the purposes for which they may be adapted.

Data for numbers of workers and labor cost are more complete for years in which Censuses of Manufacturers and Business are taken than for intervening years. Benchmark estimates were therefore made in certain census years for each of the marketing functions. Estimates for other years were determined from trends in available annual employment and wage statistics series. The several censuses vary in detail and coverage. To establish benchmark estimates, we used the latest census year for which adequate data were available. Census data for other years were used, where possible, to verify the annual estimates made from the trend series. Procedures for each function are described in succeeding paragraphs.

Processing.—Number of employees engaged in processing farm food products in 1947 and total wages, salaries, and other payments they received were estimated from data given for the Food and Kindred Products group in the Census of Manufactures for that year. Minor industries whose *principal* products were not food made from domestic farm products were excluded from the estimates. Data for the remaining industries were combined into six major food commodity groups that are similar to industry groups for which the Bureau of Labor Statistics reports data currently.[3]

For the years after 1947, estimates are computed by applying to the 1947 estimates for each of these six food commodity groups, the trends in numbers and earnings in those industries as reported by BLS. Trends in these major groups may introduce some errors. In the canning and preserving industry, the trend in labor numbers and earnings could be influenced by changes in the subgroups of industries whose principal products are from nonfarm products such as canned and cured fish and other seafood. Total labor cost by groups is obtained by multiplying average annual earnings by the estimated number of employees. Data are not available for supplements to wages and salaries by subgroups, so we used for the trend the averages computed from Department of Commerce data for the major industry group, food and kindred products.

Comparable employment and payroll series by the commodity groups are not available before 1947. Estimates of the number of employees before 1947 were obtained by applying to the 1947 estimate the trend in total number of employees in the food and kindred products group—full-time basis as reported by the Department of Commerce—after correcting the trend for estimated number in alcoholic beverage industries. The trend in average annual earnings in the food and kindred products group was applied to the 1947 estimate of average earnings of food processing employees. Average compensation—annual earnings plus supplements—was multiplied by estimated number of employees to obtain estimated labor cost.

Wholesaling.—Number of persons engaged in wholesaling farm food products, which includes local assembly, and the total cost of this labor were estimated from the Census of Wholesale Trade for 1939 instead of 1948, because commodity-sales data were less detailed in the 1948 Census. It was assumed that for each kind of wholesaler, number of employees and labor cost represented the same proportion of totals that value of sales of farm foods bore to their total sales. The 1939 sales by type of commodity were reported for three groups of wholesalers—service and limited function wholesalers, manufacturers' sales branches, and assemblers of farm products. The other two general classes of wholesalers—manufacturers' sales offices and agents and brokers—were assumed to sell only the commodities of the trade in which they were reported. For example, agents and brokers classified in the fresh fruit and vegetable trade were assumed to handle only fresh fruits and vegetables. No adjustments were made for imported produce.

It is difficult to obtain accurate trends for wholesaling of farm food in noncensus years because annual data for employment and earnings are available only for total wholesale trade. The Department of Commerce publishes annual estimates of both food sales and total sales for merchant wholesalers. These data on food and total sales were deflated by the Bureau of Labor Statistics wholesale price indexes separately for food and for all commodities. Then for each year, we com-

[3] Some establishments that process farm foods but whose major function is wholesaling or retailing—wholesalers and retailers who dress poultry, single-unit bakeries, and fluid milk distributors—are not included under processing. Estimates for wholesaling and retailing cover these firms. Some of the establishments that are included in the estimates process nonfood products as side lines; it was not possible to allow for labor required for these side lines.

puted a percentage that deflated food sales represent of deflated wholesale sales of all commodities. These percentages were used to allocate to food trade a portion of all employees in wholesale trade. This provided a series to indicate trend in number attributed to farm foods. The trend series was applied to 1939 estimates, and 1948 Census data were used to check the estimates obtained. We followed a similar procedure in allocating total wages and salaries to food. Estimates of numbers and labor costs by this method apparently were more valid than those obtained by using the trend in all wholesale trade as the trend in farm food wholesaling.

Retailing.—The number of persons engaged in retailing food—including both off-premise and on-premise consumption—were estimated from the Census of Retail Trade for 1939. The 1939 Census reported more detail on sales by commodity lines for all types of retail stores than the 1948 Census. As retail food stores sell nonfarm foods and nonfood items, only part of the total number of workers can be included in estimates relating to farm foods. Workers in retailing in 1939 were allocated according to the proportion that farm food sales represented of total sales. Allocations were made for each type of store in which sales of food were reported, including grocery stores, restaurants, drug stores, and many others. The same percentages were used to allocate employees, proprietors of unincorporated businesses, and family workers who received no stated wages. No correction for nonfarm food was made in numbers selling meals and fountain service. It was not possible to separate out all sales of nonfarm food for on-premise consumption.

For years after 1939, annual estimates of the number of paid employees in the off-premise consumption segment of the retail-food trade were derived from trends in employment reported by BLS for retail-food stores. Before 1939, census data were used for 1929, 1933, and 1935. Intervening years were filled in by the trend reported for all retail trade. The trend in employees engaged in retailing food for on-premise consumption after 1939 was established from an unpublished BLS series of numbers of employees in eating and drinking places. Before 1939, census data and the trend in all retail trade were used.

Labor costs of paid employees were computed by multiplying numbers by estimated average annual earnings, including supplements. The cost of supplements to wages and salaries for retailing food was included by applying annual percentages derived from statistics reported for all retail trade. Average annual earnings in the two segments of retailing for 1929, 1935, 1939, and 1948 are available from census data. For intervening years after 1939, a trend series was established for each segment from the BLS series on weekly earnings in retail food stores. Before 1939, average annual earnings of employees in all retail trade reported by the Department of Commerce was used for establishing the trend in intercensal years.

The numbers of proprietors and unpaid family labor in retail trade are reported for census years.[4] For noncensus years after 1939, we used the trends in number of firms in retail food stores and in eating and drinking places; before 1939, the trends in paid employees were used to make estimates in the intercensal years. Compensation of proprietors and family members was assumed to average the same as earnings of paid employees.

Transportation.—Available data are inadequate for making accurate estimates, but the labor in transportation represents a relatively small part of total labor cost in marketing food products. Estimates apply only to intercity transportation by rail and motor carriers. Estimates of numbers and labor cost in rail transportation of farm food products are based on data published by the Interstate Commerce Commission.[5] Revenues received by Class I railways for handling farm foods were obtained by totaling food items, with allocations of such products as grains to food and nonfood uses. To obtain compensation of employees handling food products, the proportion of all freight revenue represented by food was applied to the compensation allocated to freight. Compensation for freight employees was estimated by applying to all freight expense the ratio of total compensation of employees to total expense. Numbers of employees were obtained by dividing the compensation allocated to food products by the average annual earnings of railway employees, on the assumption that the average compensation of

[4] To estimate family labor on a full-time basis, we assumed that part-time labor worked 30 percent of the time. Approximately half of the family workers reported in the 1939 Census worked only part of the time.

[5] U. S. Interstate Commerce Commission. Freight commodity statistics and statistics of railways. Annual Report.

freight employees handling food was the same as the average for all employees.

Estimates for motor carriers were derived in a somewhat similar manner. Revenue for all trucks is obtained by multiplying highway ton-miles by revenue per ton-mile, published by the American Trucking Association. Revenue from trucking food products was not available; this was estimated by assuming that the percentage ratios of revenue from food to total freight revenue (excluding products of mines) derived from rail statistics, would apply to revenue of motor carriers. To estimate the labor cost in trucking food, data on compensation to employees for Class I motor carriers were used. Compensation of these employees as percentage of operating revenue was applied to the estimated revenue from transporting food. The wage and salary cost divided by average annual earnings of employees of Class I motor carriers is the estimate of number of employees engaged in trucking food.

Applications and Limitations

From the foregoing discussion it is evident that these statistics are not as accurate and reliable as we should like to have them. Several adjustments which are made in the primary data are based on rather broad assumptions. Perhaps the most serious limitations are in the estimates for retailing. Estimates for proprietors and unpaid family labor are based on inadequate data, yet they are a relatively important component of the total. In 1939 the estimated number of proprietors and family workers was slightly larger than the number of paid employees in food stores. In eating and drinking places the total number of proprietors and family workers was about half the number of paid employees. These proportions were considerably lower in 1948. Estimates for wholesaling and transportation are also based on some sketchy data but these functions account for a small part of the total.

These series probably measure year-to-year trends more accurately than they do actual levels. Estimates derived from census data are likely to underestimate the total number of laborers directly engaged in marketing farm foods. Many street vendors or local country truckers, for example, may not be included in any census.

Despite these limitations, we believe that these series have several useful applications in economic analyses of developments in marketing. Some of these suggested uses are outlined briefly, with a more detailed discussion of the index of unit labor cost and its application. A more detailed discussion of the importance of labor in marketing farm products, together with some additional statistical series, are given in recent articles in *The Marketing and Transportation Situation.*[6]

Analysis of contribution of labor services in moving products from farm to consumer.—During the last quarter of a century, workers in food-marketing firms increased about 50 percent whereas workers on farms decreased about a third. A significant part of the increase in number of workers has arisen from the expansion in services performed by the marketing system. More foods are now processed and prepared in factories. The growth in the proportion of our population living off farms has increased the need for transportation and other services. Because of this shift in population, the quantity of food products marketed has increased at a somewhat greater rate than the quantity produced.

As the workers on farms include those producing both food and nonfood products, a continuing series on numbers of all workers engaged in marketing all farm products would be most useful for this purpose. Breakdowns by component parts—food and major nonfood products—would also aid in the analysis of the contribution of labor in marketing various farm products.

Output per man-hour in marketing food products.—The increase in productivity of labor in marketing in comparison with increased productivity in agriculture is a significant question related to the analysis of change in numbers. This is discussed in detail later, with an example of a special application of these series.

Labor as cost factor in marketing.—These data can be used to measure the proportion that labor costs are of the total spread between farmers and consumers. Other data collected in connection

[6] Agricultural Marketing Service. Labor in the marketing of farm food products. The Marketing and Transportation Situation–106, pp. 17–24, May–July 1952; Labor in marketing farm products. The Marketing and Transportation Situation–113, pp. 19–30, May 1954.

with the basic series such as hourly earnings, length of work week, and cost of supplements to wages and salaries are useful in explaining changes in labor costs and their importance in the total marketing bill.

Importance of various functions in marketing.—Farm-retail price spreads often appear large unless related to all services performed by the marketing system. Distribution of laborers among marketing functions indicates the relative importance of each function.

Of the total persons engaged in marketing farm foods in recent years, about three-fifths were in retailing. Roughly, 40 percent of the total in retailing are employed in restaurants and other eating places. Employees in food-processing plants accounted for almost a fourth of the total and those in wholesaling and transportation made up the remainder. Retailing accounts for about half of the cost of labor in marketing farm food products, processing for slightly less than 30 percent. and wholesaling and transportation for approximately 10 percent each. Wage rates are lowest in retailing so that labor costs in retailing represent a smaller share of the total than indicated by the proportion of workers.

These estimates are not accurate enough for year-to-year comparisons of changes in the relative importance of each function. Census data for the processing industries are sufficiently detailed to permit more precise estimates and analysis by major groups of products.

Indexes of unit labor costs and hourly earnings.—These indexes are computed to compare trends in labor cost and hourly earnings with the trend in overall charges for marketing farm food products (table 2). The index of unit labor cost equals the index of (adjusted) total labor cost divided by an index of physical volume of food marketed for United States civilian consumption.[7] This index is thus a rough approximation of the trend in cost of labor per unit of food marketed. Unit labor cost in 1954 was about 133 percent higher than the 1935–39 average, compared with an increase of 85 percent in the overall marketing margin. Other cost factors have apparently increased at a less rapid rate than labor costs. Hourly earnings, however, increased about 200 percent in this period, which indicates that actual labor costs have increased much less than wage rates. Since 1951, unit labor cost has increased only a third as much as the rise in average hourly earnings. Data for hourly earnings in table 2 measures the trend in average compensation per hour of all persons engaged in marketing farm foods for civilian consumption. This series is obtained by dividing labor cost (adjusted as described in footnote 7) by estimates of total man-hours of labor.

The comparisons based on the series in table 2 indicate that productivity of labor in marketing food products has increased, especially in recent years. This conclusion is consistent with the stepped-up rate of increase in output per man-hour that apparently has occurred in the economy in the last year or two. Capital expenditures for new plant and equipment in the food processing and distributing industries have been large in recent years. Less rapid turnover and the availability of more skilled workers in food marketing activities also tend to increase output per man-hour.

A direct measurement of the trend in output per man-hour can be obtained from a comparison of the change in number of man-hours of labor with the change in volume of food marketed. The physical volume of food marketed for domestic civilian consumption in 1954 was about 55 percent higher than the 1935–39 average. During this same period, the number of man-hours of labor in marketing this food increased about 20 percent. Thus, the increase in physical output marketed was 30 percent greater than the increase in man-hours—equivalent to an annual average increase of around 2 percent. Output per *man* has

[7] The total labor cost shown in table 1 was adjusted to exclude labor in marketing food for noncivilian use and labor in restaurants and other eating places as the marketing-margin series measures the price spread between the farm value and retail-store cost of a fixed quantity of food products. Estimates of labor costs in retail food stores (excluding eating places) were increased to allow for additional labor costs that would have been incurred if food sold in eating places had been purchased for off-premise consumption. Adjustments for the numbers and labor cost of persons engaged in marketing food for noncivilian use were based on Agricultural Marketing Service estimates of quantities of food for exports and military use. Except for war years, the proportion of food allocated to noncivilian use was relatively small.

increased less during this period than output per *man-hour* because of a substantial decrease in the average hours worked per week.

Labor inputs in marketing are easily defined either in form of man-hours or equivalent man-years, but as yet no one has come up with an adequate method for measuring physical output in marketing. We first used as a measure of output an index of physical volume of foods marketed which was computed by weighting retail quantities of farm food for civilian consumption, using 1947–49 average retail price weights.[8] However, as marketing margins—or what might be called the "value added" in the marketing process—should be more appropriate indicators of marketing services performed than retail prices, we also computed an index of physical volume with the average 1947–49 margins of various food items as weights. With margin weights, products with low farmer's shares receive proportionately more weight than with retail prices as weights. The results obtained from these two sets were not significantly different. Apparently, long-time shifts in consumer purchases from flour to bread or other baked goods and increased purchases of other more highly processed foods with relatively low farmer's shares have been offset by increased purchases of poultry, eggs, and other products with relatively high farmer's shares. Actually, quantities and margins are not available for enough of frozen foods, bakery products, and other highly processed foods to give a precise measurement of output of marketing services by this latter method.

Monthly Series on Hourly Earnings

As a final note in this article, we shall discuss briefly the monthly series on hourly earnings of food marketing employees (table 3). Current wage statistics available from the Bureau of Labor Statistics and Interstate Commerce Commission are used to estimate average hourly earnings. These wage statistics by marketing functions are:

Processing—Average Hourly Earnings, Food and Kindred Products, BLS.

Wholesaling—Average Hourly Earnings, All Wholesale Trade, BLS.

Retailing—Average Hourly Earnings, Food and Liquor Stores, BLS.

Transportation—Average hourly earnings for Class I railroad employees computed from ICC data on total man-hours and total compensation of employees.

TABLE 2.—*Marketing margin, labor cost per unit of product, and hourly earnings of persons engaged in marketing farm food products for United States civilian consumption, 1929–54*

Index numbers (1947–49=100)

Year	Marketing margin [1]	Unit labor cost [2]	Hourly earnings [3]
1929	77	61	
1930	78	60	
1931	66	55	
1932	59	48	42
1933	56	43	40
1934	59	47	43
1935	62	51	44
1936	63	50	43
1937	64	56	46
1938	61	54	47
1939	59	54	48
1935–39 average	62	53	45
1940	58	54	48
1941	59	56	52
1942	65	58	57
1943	69	60	61
1944	70	64	65
1945	70	69	70
1946	79	77	81
1947	95	91	93
1948	102	103	101
1949	103	106	106
1947–49 average	100	100	100
1950	101	108	112
1951	109	119	120
1952	112	122	126
1953	113	123	133
1954 [4]	115	124	138

[1] Calculated from the trend in the margin between retail cost of a fixed quantity of farm food products and payments to farmers for equivalent produce in the market-basket series which is published in each issue of *The Marketing and Transportation Situation*. Margin is adjusted for processing taxes in 1933–35 and for Government payments to processors in 1943–46.

[2] Unit labor cost is the quotient of indexes of labor cost and the physical volume of food marketed for civilian consumption.

[3] Hourly earnings estimated by dividing labor cost by total man-hours.

[4] Preliminary estimate.

[8] Basic data used are the total civilian disappearances of food used for the Agricultural Marketing Service index of per capita food consumption, with corrections made for imported and nonfarm food and food consumed on farms where produced.

TABLE 3.—*Hourly earnings of paid employees in marketing of farm food products, annual 1935–54, monthly 1950–54* [1]

Year and month	Average hourly earnings
	Dollars
1935	0. 56
1936	. 57
1937	. 60
1938	. 62
1939	. 61
1940	. 62
1941	. 66
1942	. 73
1943	. 79
1944	. 84
1945	. 88
1946	1. 00
1947	1. 14
1948	1. 24
1949	1. 31
1950	1. 37
1951	1. 47
1952	1. 55
1953	1. 64
1954 [2]	1. 70
1950	
January	1. 35
February	1. 36
March	1. 35
April	1. 36
May	1. 36
June	1. 36
July	1. 37
August	1. 36
September	1. 38
October	1. 38
November	1. 40
December	1. 42
1951	
January	1. 43
February	1. 45
March	1. 45
April	1. 46
May	1. 46
June	1. 48
July	1. 47
August	1. 47
September	1. 48
October	1. 49
November	1. 50
December	1. 51
1952	
January	1. 53
February	1. 53
March	1. 53
April	1. 54
May	1. 54
June	1. 55
July	1. 55
August	1. 55
September	1. 55
October	1. 57
November	1. 59
December	1. 59
1953	
January	1. 61
February	1. 61
March	1. 61
April	1. 62
May	1. 63
June	1. 63
July	1. 63
August	1. 63
September	1. 65
October	1. 66
November	1. 68
December	1. 67
1954	
January	1. 70
February	1. 69
March	1. 69
April	1. 69
May	1. 70
June	1. 70
July	1. 71
August	1. 69
September	1. 70
October	1. 71
November	1. 73
December	[2] 1. 72

[1] Weighted composite earnings of paid employees in steam railways, food processing, wholesale trade, and retail food stores. These data are published currently on the inside cover page of *The Marketing and Transportation Situation.*

[2] Preliminary estimates.

Compiled from data published by Department of Labor and Interstate Commerce Commission.

A weighted average of hourly earnings is computed with the following weights: Processing, 37 percent; wholesaling, 17 percent; retailing, 34 percent; transportation, 12 percent. These percentage weights are based on the 1947–49 average of estimated man-hours of paid employees in the marketing of farm food products for civilian consumption, excluding employees in eating places. These weighting factors are reasonably representative of the entire period, 1935 to date.

These hourly earnings are useful as an indicator of changes in labor costs in current analyses of factors that affect changes in farm-retail price spreads. This series differs from the index of annual hourly earnings in table 2 in that it relates only to paid employees. In this monthly series constant weights are used, whereas the index of hourly earnings in the other series is derived from estimates of aggregate labor costs and man-hours for all marketing functions combined. The relative importance of each function may vary from one year to the next. Another limitation of the monthly series is that some of the wage statistics used to construct this series include some labor not engaged in marketing farm foods. The trend in the annual averages of this monthly series corresponds closely to the annual index of hourly earnings in table 2.

Sampling Aspects of a Consumer Survey of Milk Products

By Eugene E. Hixson

An accumulation of knowledge of sampling errors is valuable for purposes of improving the design of samples and the interpretation of results. This article contributes to such knowledge a comparative analysis of alternative sampling methods, based on data from a recent marketing survey.

DATA from a consumer survey of milk products [1] were analyzed to obtain estimates of random sampling errors for selected items, the effects of restrictions on the geographical dispersion of the sample, and the effects of clustering (that is, the selection of groups of households rather than individual households). A more thorough understanding of these effects should enable one to do a better job of designing samples and to see whether the well known formula $\sqrt{\frac{pq}{n}}$ can be used to provide rough approximations of the standard error of p.

This survey was conducted in October and November of 1952 in Memphis, Tenn. Its purpose was to discover and analyze factors that were influencing the decline in sales of fresh fluid milk and the upward trend in sales of nonfat dry milk solids in consumer-sized packages in the Memphis market. It was also designed to disclose consumer purchase patterns and habits in use of milk products in the homes.

The statistical population was defined as all private households residing within the city limits of Memphis, Tenn., at the time of the survey. The 1950 Census block statistics for Memphis provided information on the number of households in each block, which was used as a basis for sampling.

Each block was assigned one sampling unit if it contained from 5 to 50 occupied dwelling units. Blocks with fewer than 5 dwellings were combined with adjacent blocks, and blocks with more than 50 were assigned one sampling unit for every 50 occupied dwelling units. Then a sample of blocks was selected by choosing the block in which every nth sampling unit fell. This was done by proceeding through the bulletin on block statistics in the order that the blocks were listed.

This gave a sample of blocks with probabilities of selection proportional to the number of sampling units and with "forced" geographical dispersion [2] as the blocks were listed in a geographical order. If a selected sample block contained more than one sampling unit it was divided by means of Sanborn maps into the appropriate number of sampling units from which one was selected at random. The sampling rate was .0179, giving a total of 69 sampling units (mostly whole blocks) whose boundaries were rigidly defined.

Interviewers were instructed to make contact with all private households in selected sampling units. One set of questions was asked of all users of nonfat dry milk solids. Another set was asked of a subsample of nonusers of nonfat dry milk solids. Thus one sample of 306 users of nonfat dry milk solids and another of 308 nonusers were obtained. At least two callbacks were required at a sample household in which no one was found at home, one callback to be made after 6 p. m.

Table 1 shows results of an analysis of selected items. For each item, estimates of sampling errors were computed for three different sample designs in order to compare their efficiencies. The first method corresponds to the design actually used in the survey. The second assumes an unrestricted random sample of sampling units, that is, no restriction on the geographical dispersion of the sample. As cluster sizes are variable, estimated percentages from the two methods are ratio estimates. The third method assumes an unrestricted random sample of individual households,

[1] DWOSKIN, PHILIP B. MILK PRODUCTS: CONSUMER PURCHASE PATTERNS AND USE, MEMPHIS, TENN. U. S. Dept. Agr. Marketing Research Report No. 39, 68 pp. illus. May 1953.

[2] "Dispersion" is used instead of "stratification" because the sample is not a stratified sample in the usual sense.

which is impossible unless a list is available. The estimated standard errors for these three methods are designated s_1, s_2, and s_3 respectively. The methods of estimating the sampling error for each of these methods is shown in the footnotes to table 1.

TABLE 1.—*Analysis of the sample data*

Item	Number of households [1]	Percent of households	Estimated sampling errors			
			Cluster sampling			
			With geographical dispersion [2] s_1	Without geographical dispersion [3] s_2	Unrestricted random sampling [4] s_3	$\frac{s_1}{s_3}$
Percent of:		*Percent*	*Percent*	*Percent*	*Percent*	
All households using NFDMS [5]	1, 649	18. 6	1. 1	1. 1	1. 0	1. 10
All NFDMS households using buttermilk	306	68. 6	3. 8	3. 7	2. 7	1. 41
High income [6] NFDMS households using buttermilk	105	72. 4	4. 2	4. 7	4. 4	. 95
Negro NFDMS households using buttermilk	79	86. 1	4. 7	4. 5	3. 9	1. 21
All non-NFDMS households using buttermilk	308	64. 9	2. 7	3. 0	2. 7	1. 00
High income [6] non-NFDMS households using buttermilk	98	63. 3	5. 2	5. 2	4. 9	1. 06
Negro non-NFDMS households using buttermilk	75	86. 7	3. 1	3. 5	3. 9	. 79
All NFDMS households using evaporated milk	306	79. 7	3. 6	3. 5	2. 3	1. 57
High income [6] NFDMS households using evaporated milk	105	75. 2	6. 4	6. 1	4. 2	1. 52
Negro NFDMS households using evaporated milk	79	91. 1	5. 9	5. 8	3. 2	1. 84
All NFDMS households using NFDMS less than 6 months	306	21. 9	3. 1	2. 9	2. 4	1. 29
All NFDMS households who drink buttermilk made from NFDMS	306	33. 7	2. 9	2. 9	2. 7	1. 07
Cream using, non-NFDMS households using cream bought only in stores	110	53. 6	6. 1	5. 7	4. 8	1. 27
Homemakers having heard of or used NFDMS more than 6 months, who think: NFDMS has less food value than fresh milk	292	23. 9	2. 8	2. 8	2. 5	1. 12
Fresh milk using, NFDMS households who only buy home delivered milk	287	24. 0	3. 0	3. 2	2. 5	1. 20
Fresh milk using, middle income [7] NFDMS households who only buy home delivered milk	93	33. 3	4. 4	4. 5	4. 9	. 90
NFDMS households having fresh milk home delivered because it is: convenient, handy, or less trouble	138	49. 3	4. 5	4. 4	4. 3	1. 05
NFDMS households who do not have home delivery now but have had in the past, because: Use less, family needs change	73	21. 9	5. 4	5. 1	4. 8	1. 13
Fresh milk using, NFDMS households who prefer cartons to bottles	287	20. 9	2. 6	2. 4	2. 4	1. 08
Fresh milk using, NFDMS households who prefer bottles to cartons, because: Don't like taste, flavor or smell of cartons	193	21. 8	2. 8	3. 1	3. 0	. 93

[1] This column contains the number of households upon which the percents in the next column are based.

[2] In order to estimate sampling errors for this design, a procedure analogous to the "collapsed strata" technique was used to account for the geographical dispersion. (That is, the 69 sampling units were defined as 23 sets, each containing 3 sampling units, where the assignment of sampling units to a set coincided with the order of sample selection.) The estimated standard error of a percent for this design is given approximately by the formula:

$$s_1=\sqrt{\frac{\sum_{i=1}^{c}\sum_{j=1}^{m_i}X^2_{ij}-\sum_{i=1}^{c}\frac{X^2_i}{m_i}}{\bar{n}^2m(m-c)}}$$

where k_{ij}=total number of homemakers responding yes to item k in the jth sampling unit and the ith set.

n_{ij}=total number of homemakers who were asked item k in the jth sampling unit and the ith set.

m_i=number of sampling units in the ith set.

$m=\sum_{i=1}^{c} m_i$, total number of sampling units in the sample.

$\bar{n}=\sum_{i=1}^{c}\sum_{j=1}^{m_i} n_{ij} \Big/ m$, average number of homemakers per sampling unit who were asked item k.

c=number of sample sets.

Footnotes continued on p. 52.

A comparison of s_1 and s_2, item by item, reveals that no appreciable gain was accomplished by geographical dispersion. In order to compare the given design with unrestricted random sampling, $\frac{s_1}{s_3}$ was computed. This comparison measures the combined effects of clustering and geographical dispersion. It also shows how well $\sqrt{\frac{pq}{n}}$ approximates the standard error of the design used. The data show that $\frac{s_1}{s_3}$ varies considerably for the different items. Since the effect of geographical dispersion was generally small, the variation in $\frac{s_1}{s_3}$ from item to item must be due primarily to differences in the intrasampling unit correlation or clustering effect. The greater the value of $\frac{s_1}{s_3}$, the greater the tendency for households within a sampling unit to be alike, and the greater the loss in statistical efficiency from use of large sampling units rather than small sampling units.

Clustering effects appear to be greatest for those users of nonfat dry milk solids who use evaporated milk. But a study of the data for individual blocks revealed that most of the effect of clustering is attributable to one or two blocks. The ratio of $\frac{s_1}{s_3}$ exceeded 1.25 for six items and was 1.00 or less for five items. Unpublished results from some investigations have indicated a smaller range in the values of $\frac{s_1}{s_3}$ from item to item and that $k\sqrt{\frac{pq}{n}}$ could be used as an expedient for getting a rough approximation of the sampling standard error of a percentage, where k is a constant equal to about 1.25. For this particular study, use of the "expedient" would be questionable. However, the s_1's are subject to rather large sampling errors so the "expedient" might have some value, particularly if the alternative is to have no information on sampling error.

In surveys of this type, where many estimates are to be made, one tries to design a sample that is near optimum for the more important items or for the majority of items. Thus, if one has some knowledge of the average cluster effect for the items of most interest, he can estimate the required sample size for an unrestricted random sample by using $\frac{pq}{n}$, and then multiply this sample size by the factor $\left(\frac{s_1}{s_3}\right)^2$ to obtain a rough estimate of the sample size necessary for a cluster sample.

Footnotes continued from p. 51.

$$X_{ij}=k_{ij}-p\ (n_{ij})$$

$$p=\sum_{i=1}^{c}\sum_{j=1}^{m_i}k_{ij}\Big/\sum_{i=1}^{c}\sum_{j=1}^{m_i}n_{ij}$$

$$X_i=\sum_{j=1}^{m_i}X_{ij},\ \text{total of } X_{ij} \text{ for the ith set.}$$

[3] The estimated standard error of a percent for this design is given approximately by the formula:

$$s_2=\sqrt{\sum_{i=1}^{c}\sum_{j=1}^{m_i}X^2_{ij}/\bar{n}^2m(m-1)}$$

[4] The estimated standard error of a percent for this design is given approximately by the formula:

$$s_3=\sqrt{pq/n}$$

where: $q=1-p$

$$n=\sum_{i=1}^{c}\sum_{j=1}^{m_i}n_{ij}$$

[5] NFDMS is used as abbreviation for nonfat dry milk solids.

[6] A weekly gross family income of $100 and over.

[7] A weekly gross family income of $50–$99.

Book Reviews

Economic Change in America [*Readings in the Economic History of the United States.*] Edited by Joseph T. Lambie and Richard V. Clemence. The Stackpole Company, Harrisburg, Pa. 599 pages. 1954. $5.75.

TWO PAPERS by the late Professor Schumpeter, appropriately enough, begin this comprehensive collection of readings on economic change in America. In these two papers, first published as journal articles in 1947, Schumpeter emphasizes the role of "entrepreneurship" as a factor of economic growth. He distinguishes between passive and creative responses to changed circumstances and new inventions, and attributes to the entrepreneur the role of creative response leading to economic growth. The defining characteristic of the entrepreneur and his function, according to Schumpeter, is simply the doing of new things or the doing of things that are already being done in a new way (innovation).

In two following papers Arthur H. Cole places entrepreneurship and its history in its institutional setting. And A. H. Hansen in a discussion of secular trends and business cycles tends to support the view of Schumpeter that innovations (and technological developments) play a major part in economic growth. Hansen also supports the view, "to a greater or less degree," that fiscal policies of governments, at times, and in the past related mainly to wars, provide one of the main causes of upswings and downswings of prices and the somewhat loosely associated phenomena of business prosperity and depression. To gold and other purely monetary factors Hansen attributes a subsidiary role.

The 33 chapters that make up the remainder of the readings from books and journal articles disclose the diversity of elements entering into economic change in America and in interpretations of such change. The major theme of continuing growth of all sectors of the economy through the innovating activities of entrepreneurs runs through much of the book.

The role of governmental policies and measures, and of science, receives prominent attention. Government policies and measures are treated in articles dealing with the theory and recent history of antitrust activities, land policies and use of natural resources, the effect of the Homestead Act of 1862 in restricting the mobility factor of the frontier, and early transportation and banking enterprises of the States in relation to growth of corporations. The last-named article, first published in 1903, is refreshing in its style and its scholarly analysis of the forces that motivated the States to enter into or assist in the development of canals, turnpikes, and banks in the early part of the 19th century. Also treated are the history of the Federal debt, development of central banking, economic growth as affected by tariff protection, and the foreign economic relations of the United States.

Science and invention were necessary handmaidens to the rapid economic growth of the United States, particularly in the last 100 years. One article stresses invention as a function of social forces of the time. Another points up the haphazard nature of employment of science in industry during most of the 19th century; nevertheless there were scientists and there were inventors actively at work, and these led the way to the great industrial research laboratories of the present day. Among many interesting sidelights in this article is the experience of the Carnegie Company in employing a German chemist to analyze iron ores, and the discovery, in the words of Carnegie, that "the good was bad and the bad was good." A third article traces the history of three inventor-entrepreneurs—Marconi, Fessenden, and de Forest—and their successes and failures as businessmen in launching a new industry, radio.

Attention is given to the business man, his origin and motivations; to agriculture, including the well-known article by Ellickson and Brewster on the effect of mechanization on the family-size

farm; to banking and finance; and to labor and population, including among others the illuminating article by Perlman concerning the basic philosophy of the American labor movement.

The book is divided into nine sections, each of which is preceded by a brief introduction by the editors. Their intent is to present a volume of supplementary readings primarily for the use of undergraduate students. In its wide diversity of subject matter and, on the whole, skillful array of articles, the book carries out that intent. One might wish, for the convenience of intellectually curious but unspecialized students, that some of the sections could have been developed at greater length.

Robert M. Walsh

Big Enterprise in a Competitive System. By A. D. H. Kaplan. The Brookings Institution, Washington. 269 pages. 1954. $4.

AFTER SHOWING that American business concerns have grown in size and power, Dr. Kaplan concludes his valuable book with this sentence:

"Big business has not merely been kept effectively subject to a competitive system; on the whole it has also made an essential contribution to its scope, vitality, and effectiveness."

Of course, the author does not claim that the power of big business is always so used as to benefit the public. But neither does he see evidence of a serious decline in competition, nor the end of democracy in business enterprise. Rather, he sees healthy competition between large and small businesses, with the public reasonably well protected by the Government.

It is too often assumed that Governmental policy with respect to big business is, and should be, directed solely to the maintenance of full and free competition. But, as Dr. Kaplan shows in his first chapter, the opposition to big business practices is frequently not upon the grounds that they are anti-competitive—rather, that the competition is too intense, too aggressive, too ruthless. Economists are revising their ideas about the nature of competition. At the same time, they are revising their ideas about public policy. Dr. Kaplan's excellent books provide a great deal of information that should help this revision along.

Especially noteworthy is the chapter, "Price Competition in Big Business." The moral of this chapter is that price competition is only one aspect of modern competition. Prices may be administered and inflexible in some industries, yet competition may be intense. It takes other forms—product differentiation, servicing, promotions, for example. Price rivalry has been deemphasized, but other forms of rivalry have largely replaced it.

In my opinion, our agricultural marketing research has not given enough attention to the problems analyzed in this book. What kind of competition do we have in meat packing? In the tobacco industry? In the grocery chain systems? Is this kind of competition good for the farmers and the consumers? If not, what can and should be done about it? A. C. Hoffman and W. H. Nicholls have done good pioneering work in this field, but much more is needed if we are to understand how our agricultural marketing system works, and if we are to develop policies that are truly in the public interest.

This is a controversial field of research. As Dr. Kaplan points out, "There is no scientific, entirely objective way of reaching a conclusion from which personal value judgments have been completely removed." Dr. Kaplan has presented a wealth of scientific, objective statistics and factual material that will help anyone to understand the problems associated with big business. He has given us an interesting and penetrating analysis. His conclusions are important, even though some students may disagree with them.

I think that Dr. Kaplan has made a strong case that "the major job can be left to private competition, under Government regulation." Perhaps the main weakness of the book is that it does not specify the extent and kinds of Government regulation that are needed.

Frederick V. Waugh

Rural Social Systems and Adult Education. A committee report by Charles P. Loomis, chairman; J. Allan Beegle, editor; and others. Michigan State College Press, East Lansing. 392 pages. 1953. $5.

THE ASSOCIATION of Land Grant Colleges and Universities sponsored, and the Fund for Adult Education financed, this comprehensive study of the present status of adult education in rural America. The 14 authors present an excellent description of the nature and the function of the several rural social systems of adult education, as well as the channels of communication that provide the information and attitudes that stimulate change.

A compact chapter by Charles Loomis on rural social systems opens the book. This is good reading for foreign visitors before beginning their tours of our land grant colleges. The volume has chapters on adult education activities sponsored by public schools, extension services, farmers' organizations and cooperatives, men's and women's service clubs and civic organizations, agencies within the Department of Agriculture, public libraries, rural churches, colleges and universities, local government, and mass media. There is an intriguing chapter on the influence of international exchange of persons on international understanding.

The book is particularly good in its description of the extent and distribution of adult education activities throughout the United States and in documenting interagency working relationships. The latter is rarely described in the literature. "The 'big five' agencies of rural adult education which work together most frequently and intensively, as judged by leaders, are: farm organizations, schools, churches, the cooperative extension service, and civic service clubs, in the order named. Other organizations than the 'big five' play relatively insignificant roles in the cooperative communication systems whereby rural people may be reached across organization lines."

Particular attention is given to determining the extent to which programs in the fields of international understanding for peace, strengthening democracy, and understanding the economy are included in adult education programs, these being of particular interest to the Ford Foundation, which financed the project. The authors found that programs of this type are most likely to be included in the activities of general farmers' organizations, the extension service, Rotary clubs, churches, and college sponsored programs. A surprisingly low number of the adult education programs of rural high schools contained these three types of topics. This was also true of women's clubs, library sponsored activities, and some service clubs other than Rotary.

Significant facts abound here, such as the sources of information about other countries—89 percent of the Rotary clubs in the rural counties studied had placed a foreign person somewhere on their programs the previous year.

Sources for most of the data were field interviews and questionnaire studies in 263 rural counties representing types of farming areas throughout the United States. A description of the sample and copies of the questionnaires are published in an appendix.

This book is a first-rate inventory of adult education activities in rural United States. It is the kind of a book that you can place in a man's hands and say, "Here, this will tell you about the many different ways our farmers receive information about world affairs." The very scope of the book and its wealth of data encouraged this reader to pause and ponder its implications for professional work. It is recommended reading for all concerned with the education of our rural citizens.

Robert A. Polson

American Farm Life. By Lowry Nelson. Harvard University Press, Cambridge. 178 pages. 1954. $3.75.

THE PURPOSE of this book is to acquaint nonfarm people with the people who live by farming—the less than a sixth of our population. The book does not discuss rural conditions per se, but rather the farming element of the rural population. It deals with the heritage of our farmers from the founding of the country to the present. The book presents a general survey of number, size, and distribution of farms and farmers in the United States, technological advances that have been made and that are likely to be made, and facts about the farm labor force, showing how it has declined as mechanization has increased.

Other subjects dealt with are the farm community, the farm family, schools, churches, farm organizations, and cooperatives. Unusually penetrating chapters are concerned with the farmer and his local and Federal Government. The book concludes with a chapter on the new farmer, in which the author indicates that further changes are to be expected in the future.

With expanding use of electricity, improved roads and mechanical power, and further consolidation of institutions in the trading centers, less differential between farm and city dwellers is indicated. In the author's view, Government will continue to have a large role in protecting farmers from natural disasters and economic crises. Farm depressions, he reminds us, have been forerunners of general depressions, and these are "no longer viewed as acts of God, but as man-made; as such they are subject to human control."

In contrasting the relation of farmers to Government today with that of a few years ago, Nelson summarizes: "There is scarcely a farmer in the United States at mid-century who is not familiar with the appearance of a Federal Government check; in 1930 there was scarcely one who was."

The author does not emphasize, or overlook, the fact that many farmers are without modern implements and household facilities, or that migrants and other farm laborers and many small operators have received relatively little if any benefits from recent ameliorative agricultural programs. He says "legislation has favored the 'haves' and left the 'have-nots' little better off than they were before. There are a million migratory workers and upwards of another million poor farm operators for whom little has been done, and whose welfare must be the concern of leaders in the years ahead."

Agricultural economists and subject-matter technicians will find this book a handy reference, for it presents basic materials, often in statistical form. It will be of value, too, to visitors from abroad who are interested in getting a summary of current American farm conditions.

Arthur F. Raper

The Economic Theory of Agricultural Production. By Lauri O. af Heurlin. The Finnish Academy of Science and Letters, Helsinki. 130 pages. 1954. 450 mk.

THIS MONOGRAPH seeks not only to systematize the treatment of land as an economic resource but to build a theory of agricultural production around land. It will be of particular interest to those who are interested in land classification and land utilization.

According to the author, the economic problems of agricultural production are mainly deducible from the principle of the "two-dimensional quality of land." These two dimensions are inherent fertility and exploitability. Land is said to be relatively low in exploitability if the non-rental expenses for a given quantity of product are high, relative to production on another grade of land.

Several propositions are examined by means of a rigorous geometrical analysis, first on the assumption of fixed proportions of land and of other inputs to produce a given commodity, and then on the assumption of diminishing marginal substitutability between land and non-land inputs.

The first situation dealt with has to do with the use of different qualities of land in the production of a given commodity, and the effects of changes in price of the commodity upon rents and land use. It is observed that differences in fertility may not be reflected in rents if the lands in question inversely differ in exploitability. For a given commodity, lands of equal exploitability per unit of product will come into production at a given price, regardless of differences in fertility. In this case, rent will be inversely proportional to the area required to produce a given quantity of the product. In connection with the "order of cultivation," the Ricardo-Carey controversy is taken up, and Ricardo's position is explained in terms of fertility and Carey's in terms of exploitability, for lands that are more accessible are *ipso facto* more exploitable.

With respect to rent, the author holds that differences in land quality are not essential to rent. Land is priced in the same way as any other scarce factor, and lands of different qualities are priced according to their rates of substitution for each other.

Improvements in agricultural technology are classed as *independent* if adoption will increase either fertility or exploitability and will decrease neither. A *dependent* improvement is one which increases either fertility or exploitability but decreases the other. Price changes affect profitability of these classes of improvements in different ways.

Extension of the analysis to the case of two commodities that may be grown on a given quality of land is discussed in terms of the relationship between the non-rental expenses and the area of land required for cultivation of a unit of each commodity. The comparative suitability of two lands in the cultivation of two commodities is also examined in order to ascertain the kind of land most suitable for cultivation of a certain commodity. This problem is discussed almost entirely in terms of fixed coefficients, with only brief mention of the more complex relationships involved when there is substitutability between land and non-land inputs in production of each commodity.

This monograph renders a service in pointing out the inadequate attention that has been given to the nature of land as an economic resource. The author recognizes that the lumping of all non-land inputs into a single ensemble to accommodate analysis by plane geometry limits the exposition of the theory. It may be questioned that so much importance should be given to land in the theory of production. It may also be argued that fertility and efficiency are not always easily distinguished from each other and that some measure of economic productivity may be a more useful basis for indicating soil differences. It is to be hoped, however, that this scholarly exploration of the role of land in production will stimulate further analysis of this difficult area in production economics theory.

Orlin J. Scoville

Selected Recent Research Publications in Agricultural Economics Issued by the United States Department of Agriculture and Cooperatively by the State Colleges [1]

Anderson, Dale L., and Shaffer, Paul F. principles of layout for self-service meat departments. U. S. Dept. Agr. Mktg. Res. Rept. 77, 37 pp., illus. November 1954. (RMA)

Productivity, measured in sales per man-hour, increased about one-fourth in 7 self-service meat departments when they were remodeled according to principles set forth and when certain improved methods, materials, and equipment were used.

Bayton, James A., and Bell, Hugh P. preferences for canned orange juices that vary in brix-acid ratio. U. S. Dept. Agr. Mktg. Res. Rept. 76, 30 pp., illus. December 1954.

Findings of study suggest that producers might well market two different kinds of orange juice—one about 12 Brix-acid ratio, a relatively tart juice, and one about 18 Brix-acid ratio, a relatively sweet juice.

Coffman, Robert J., and Johnson, Hugh A. agricultural land use in alaska: a study of alaska by areas. Palmer, Alaska, Alaska Agr. Expt. Sta. and Agr. Res. Serv. 53 pp., illus. September 1954.

Based on the 1939 and 1950 Censuses of Agriculture, this report shows that between these 2 years, the number of farms in Alaska dropped and the acreage of farmland also decreased. The number of fur farms dropped from 164 in 1939 to 18 in 1950. The number of grazing operations also fell, but numbers of other types of farms increased. Chief change in land use was a decrease in harvested cropland and an increase in pasture.

Cross, A. J., and Wills, J. E. organization and operation of farms in the claypan area of southern illinois. Ill. Agr. Expt. Sta. Bull. 579, 55 pp., illus. August 1954. (BAE cooperating.)

A survey of 198 Wayne County farms, 30 acres and larger, selected by random sampling, showed that tenure is particularly significant in this area; that higher production per acre and per farm, a balanced fertility program, and more capital are needed on all the farms; and that production and income possibilities in the claypan area far exceed what was thought possible a few years ago.

Efferson, J. Norman, Hathorn, Roane, and Gerlow, Arthur. an economic study of rough rice storage in the southern states. U. S. Dept. Agr. Mktg. Res. Rept. 75, 57 pp. November 1954. (Louisiana Agr. Expt. Sta. cooperating.) (RMA)

A study of storage facilities in relation to storage needs in the southern rice area, the costs of storage, the problems of storing rough rice, and possible solutions to these problems.

Hoglund, C. R. soil conservation in michigan—progress and problems. Mich. Agr. Expt. Sta. Spec. Bull. 394, 36 pp., illus. January 1955. (Agr. Res. Serv. cooperating.)

A study made of 157 planned farms and 119 nonplanned farms in Barry, Hillsdale, Livingston, Osceola, and Tuscola Counties, Mich., showed that from 70 to 80 percent of the cooperators in each of the 5 soil conservation districts believed that their farm plans were workable. The remaining 20 to 30 percent had decided that the changes in farm organization and practices provided for in their initial farm plans were too drastic or did not provide sufficient flexibility. From 10 to 30 percent in each district had made progress in applying one or more parts of the plan.

Harding, Paul L., Lutz, J. M., Radspinner, W. A., and Sunday, Milliard B. influence of chemical treatments and polyethylene bags on keeping quality of florida grapefruit. U. S. Dept. Agr. AMS–8. January 1955. (Processed.)

Reports the effects of prestorage chemical treatment of Marsh grapefruit from different groves and the use of various liner combinations on keeping quality.

Harvey, E. M., Atrops, E. P., Hruschka, H. W., and Barber, H. R. shipping and cooling-in-car tests with oranges in fiberboard cartons in different load patterns, 1953. U. S. Dept. Agr. AMS–2, 38 pp., illus. November 1954. (Processed.)

Some of the loads tested were experimentally opened to provide greater space for air circulation. The greater air flow seemed to improve somewhat the cooling-in-car performance. The T load, one of the patterns introduced in the tests, was considered promising enough to warrant extensive commercial trial.

Kaiser, Verle G., Pawson, Walter W., Groeneveld, Menno H. H., and Brough, Owen L., Jr. soil losses on wheat farms in the palouse wheat-pea area, 1952–53. a progress report. Wash. Agr. Expt. Sta. Cir. 255, 11 pp., illus. September 1954. (Soil Conservation Serv. and Production Econ. Res. Br., Agr. Res. Serv. cooperating.) (A supplemental report, 19 pp., illus. September 1954.) (Processed.)

In a study based on data obtained from 557 fields, it was found that soil losses occur mainly on fields seeded to winter wheat; that these losses are affected by the previous cropping system; that a heavy growth of wheat

[1] Processed reports are indicated as such. All others are printed. State publications may be obtained from the issuing agencies of the respective States.

cuts soil losses on summer fallow land, as does stubble mulch; that barley as a nurse crop controls erosion better than peas; that heaviest soil losses occur on steep slopes.

KING, R. A., and SEALE, A. D., JR. VEGETABLE MARKET STRUCTURE CLASSES IN THE SOUTHEAST. N. C. State College, A. E. Information Series No. 35, 24 pp., illus. October 1954. (AMS cooperating.) (Processed.)

An attempt was made to provide a framework for studies of efficiencies in market organization throughout the Southeast. A classification scheme based on production patterns was developed on the assumption that recommendations made for one area may prove valuable in areas having similar production conditions.

MEYERS, TRIENAH. WOMEN'S OPINIONS OF FIBERS IN SELECTED ITEMS OF CLOTHING. PRELIMINARY SUMMARY REPORT. U. S. Dept. Agr. AMS–11, 6 pp., February 1955. (RMA)

Gives timely information on some of the findings of a study made in 1954. A full report, including comparison data for 1946, will be published later.

MOTHERAL, JOE R., THOMAS, HOWARD E., and LARSON, OLAF F. MIGRATORY FARM WORKERS IN THE ATLANTIC COAST STREAM, WESTERN NEW YORK, JUNE 1953. A PRELIMINARY REPORT. New York (Cornell) Agr. Expt. Sta., Dept. Rural Sociol. Mimeogr. Bull. 42, 30 pp., illus. June 1954. (New York State Ext. Serv. and Agri. Res. Serv. cooperating.)

Most of the more than 30,000 migratory workers employed on farms in New York each year originate in Florida. This study of a randomized sample of domestic Negro workers, which make up about three-fourths of the total migratory labor force, showed that the workers averaged 3.2 work locations in the year preceding the interviews; that they worked an average of 207 days during the year; and that their earnings for the year averaged $1,220 for all workers above the age of 9. The majority were reasonably well satisfied with working conditions in New York.

MYERS, K. H., and PASTO, J. K. GRASSLAND IN ORGANIZATION OF DAIRY FARMS IN NORTHEASTERN PENNSYLVANIA. Pa. Agr. Expt. Sta. Bull. 583, 25 pp. September 1954. (Production Econ. Res. Br., Agr. Res. Serv. cooperating.)

In the early 1950's grass was important on these farms, both in area of cropland occupied and in contribution to total feed supply. On small farms, much of the additional grass was used for hay. On large farms, it was used more frequently for silage or pasture. The amount and kind of forage produced appeared to affect farm incomes.

NATIONAL SOIL AND FERTILIZER RESEARCH COMMITTEE, THE FERTILIZER WORK GROUP. FERTILIZER USE AND CROP YIELDS IN THE UNITED STATES. U. S. Dept. Agr. Agr. Handb. 68, 75 pp., illus. December 1954. (Soil and Water Conservation and Production Econ. Res. Branches, Agr. Res. Serv. cooperating.)

This handbook represents the first attempt to make a nationwide summary of fertilizer-response data and to estimate changes in yield that might result from increases or decreases in fertilizer application rates. The tables present the most indicative picture possible on the basis of existing information.

REUSS, L. A. FLORIDA'S LAND RESOURCES AND LAND USE. Fla. Agr. Expt. Sta. Bull. 555, 52 pp., illus. November 1954. (Agr. Res. Serv. cooperating.)

In the last 10 to 15 years, the pattern of land use in Florida has changed substantially. Acreages of citrus fruit and vegetables increased materially. Production of beef expanded partly because old croplands and native rangelands were converted to improved pastures. Further large increases in production and shifts in land use are probable.

SAUER, E. L., and CASE, H. C. M. SOIL CONSERVATION PAYS OFF: RESULTS OF TEN YEARS OF CONSERVATION FARMING IN ILLINOIS. Ill. Agr. Expt. Sta. Bull. 575, 24 pp., illus. [April 1954] (Soil Conservation Serv. cooperating.)

In the 10-year study reported here, the net earnings of a group of high-conservation farms in McLean County, Ill., averaged $4.77 per acre higher than those of a comparable group of low-conservation farms (based on 1945 price level). In Madison and St. Clair Counties, the difference was $6.98 in favor of the high-conservation farms; and in Stephenson, Jo Daviess, and Winnebago Counties, it was $6.41.

SEALE, A. D., JR., and KING, R. A. VEGETABLE PRICES AND MARKETING PROCEDURES. A PROGRESS REPORT. N. C. State College, A. E. Information Series No. 38, 31 pp., illus. January 1955. (AMS cooperating.) (Processed.)

Describes price variability and other characteristics of vegetable auction markets in southeastern North Carolina and suggests some alternative marketing procedures.

SEALE, A. D., JR., and KING, R. A. VEGETABLE PRODUCTION AND MARKET OUTLETS, SOUTHEAST NORTH CAROLINA, 1952. N. C. Agr. Expt. Sta. A. E. Information Series No. 36, 56 pp., illus. December 1954. (AMS cooperating.) (Processed.)

Objective of this report is to describe existing market outlets and their relationship to the organization of vegetable producing farms in two areas of North Carolina.

SHAFFER, PAUL F., and ANDERSON, DALE L. SOME COMPARATIVE METHODS OF PACKAGING POTATOES AND ONIONS AT THE POINT OF DISTRIBUTION. U. S. Dept. Agr. AMS–12, 14 pp., illus. January 1955. (Processed.) (RMA)

Compares productivity and costs in 6 methods of bagging potatoes and onions in a retail store and 2 methods of bagging potatoes in a central warehouse.

SHUFFETT, D. MILTON. THE DEMAND AND PRICE STRUCTURE FOR SELECTED VEGETABLES. U. S.

Dept. Agr. Tech. Bull. 1105, 133 pp., illus. December 1954. (RMA)

Discusses the principal economic forces that influence the price and consumption of six important vegetable crops.

SWANTZ, ALEXANDER. THE MARKETING AND PRICING STRUCTURE FOR BULK SWEET CREAM IN KANSAS, MISSOURI, AND OKLAHOMA MARKETS. U. S. Dept. Agr. Mktg. Res. Rept. 74, 58 pp., illus. November 1954. (RMA)

Analyzes data collected on sales in 1951, 1952, and 1953 to determine the price structure and marketing practices for sweet cream in the area studied.

THOR, ERIC. COST ANALYSIS OF BULK HANDLING METHODS FOR FRESH CITRUS. Fla. Agr. Expt. Sta. Agr. Econ. Mimeo. Rept. 55–1, 33 pp., illus. September 1954. (AMS cooperating.) (Processed.)

Costs of the three bulk methods of handling fresh citrus from the tree onto the dump belt are compared with the standard field box procedures in use by the industry.

UNITED STATES AGRICULTURAL MARKETING SERVICE. FARM POPULATION . . . MIGRATION TO AND FROM FARMS, 1920–54. U. S. Dept. Agr. AMS–10, 26 pp. December 1954. (Processed.)

Gives the latest estimates of the farm population for geographic divisions and regions, of migration to and from the farm population, and of births and deaths of persons living on farms.

UNITED STATES AGRICULTURAL MARKETING SERVICE. A REPORT OF THE NATIONAL MARKETING SERVICE WORKSHOP, COLUMBUS, OHIO, NOV. 16–18, 1954. U. S. Dept. Agr. AMS–9, 75 pp. December 1954.

This report contains the talks made at the conference, the conclusions of the six commodity working groups as to the best ways of performing the four types of service studied, and a list of the persons attending the conference.

U. S. CONGRESS. COMMITTEE ON AGRICULTURE. A STUDY OF ALTERNATIVE METHODS FOR CONTROLLING FARM MILK PRODUCTION AND SUPPORTING PRICES TO FARMERS FOR MILK AND BUTTERFAT. Letter from Secretary of Agriculture Transmitting A Report Giving Information With Respect to Various Methods of Production Control and Various Methods of Price Support Which Could Be Made Applicable to Milk and Butterfat and Their Products. U. S. 84th Cong., 1st sess., House Doc. 57, 102 pp. 1955.

VOELKER, STANLEY W. MINERAL RIGHTS AND OIL DEVELOPMENT IN WILLIAMS COUNTY, NORTH DAKOTA. N. Dak. Agr. Expt. Sta. Bull. 395, 55 pp., illus. September 1954. (Production Econ. Res. Br., Agr. Res. Serv. cooperating.)

The most common methods by which interests in oil and gas in their natural state may be held are listed as: (1) mineral rights incident to the ownership of land, mineral rights conveyed by deed, or mineral rights retained by reservation; (2) mineral rights under oil and gas leases granted by the mineral owners; and (3) royalty interests under royalty assignment or royalty reservation. From May 1948 (the start of the current oil play in Williams County) to May 1, 1952 (the closing date of the study on which this report is based), nearly 1,100,000 acres in that county were placed under oil and gas lease. In some cases, fractional mineral ownership was a problem.

WILLS, J. E., and KOELLER, HAROLD L. EMPLOYMENT AND INCOME OF RURAL FAMILIES IN SOUTHERN ILLINOIS. Ill. Agr. Expt. Sta. Bull. 580, 24 pp., illus. August 1954. (U. S. Dept. Agr. cooperating.)

In Franklin County, Ill., 54 percent of the rural families were dependent on nonfarm work; in Wayne County, 37 percent depended on nonfarm work. In Franklin County, 14 percent, and in Wayne County, 13 percent, were part-time farmers with 4 or more months of farm work. They produced for sale and many planned to develop full-time farms. The rest of those dependent on nonfarm work produced nothing for sale and only about half produced food for home use. These 2 counties are representative of the 16th southernmost counties of Illinois.

Statistical Compilations

BANKS, MELVIN R. CAPACITY OF REFRIGERATED WAREHOUSES IN THE UNITED STATES (AS OF OCTOBER 1, 1953). U. S. Dept. Agr. Statis. Bull. 148, 34 pp., illus. December 1954.

UNITED STATES AGRICULTURAL MARKETING SERVICE. DAIRY AND POULTRY MARKET STATISTICS, 1953. U. S. Dept. Agr. Statis. Bull. 151, 125 pp. December 1954.

UNITED STATES AGRICULTURAL MARKETING SERVICE. MILK PRODUCTION ON FARMS AND STATISTICS OF DAIRY PLANT PRODUCTS, 1954. U. S. Dept. Agr. 47 pp. February 1955. (Processed.)

UNITED STATES AGRICULTURAL MARKETING SERVICE. PRODUCTION OF MANUFACTURED DAIRY PRODUCTS, 1953. U. S. Dept. Agr. Statis. Bull. 152, 37 pp., illus. December 1954.

UNITED STATES AGRICULTURAL MARKETING SERVICE. RATIONS FED TO MILK COWS, 1954. U. S. Dept. Agr. AMS–6, 22 pp., illus. January 1955.

UNITED STATES AGRICULTURAL MARKETING SERVICE. WOOL STATISTICS AND RELATED DATA. U. S. Dept. Agr. Statis. Bull. 142, 135 pp. September 1954.

Walker, Gaylord L. industrial molasses—an annual market review. U. S. Agr. Mktg. Serv. 26 pp., illus. November 1954. (Processed.)

Walsh, Lillian V. wholesale prices of fresh fruits and vegetables and auction prices of fresh fruits at new york city and chicago and f. o. b. prices at leading shipping points, by months, 1953. U. S. Dept. Agr. Statis. Bull. 149, 44 pp., November 1954.

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